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EDITORIAL

A change in the name of this journal suggested itself as being a necessary sequel to the separation of the School of Forestry from the administrative control of the College of Agriculture, in 1916. But for certain reasons which then seemed plausible, no definite steps have since been taken toward this end.

The nature of the contents of this paper, however, which lately had devoted itself exclusively to the publication of agricultural materials and the formal assumption by the college of the responsibility for the paper, made it advisable that the change be made as soon as circumstances would permit. The beginning of the present volume gives us an opportunity to make such a change. In view of this event, we make this an occasion to invite the attention of our readers to the fact that this publication of the College of Agriculture, formerly known as THE PHILIPPINE AGRICULTURIST AND FORESTER, will now appear under a new name: THE PHILIPPINE AGRICULTURIST.

With the present number, the journal is beginning its seventh year of publica-

tion. We beg, in this connection, to make a sincere expression of gratitude for the past co-operation of our many readers, whose forbearance, on a number of occasions when our issues were unavoidably irregular during many a trying moment in the existence of the AGRICULTURIST, saved us more than once from giving way to discouragement. To the commercial houses that very kindly sent us material support by advertising on our pages and more particularly to Messrs. E. C. McCullough & Co., who have maintained the uniformly excellent quality of printing for us almost continuously from the first volume of this paper, we are greatly indebted.

We are hoping for the same encouraging attitude from our readers as before; and the editorial and managing staffs of THE PHILIPPINE AGRICULTURIST will, on their part, see to it that everything possible is done to benefit the friends of this paper.

The Bean Fly*

By FAUSTINO OTANES Y QUESALES

Thesis presented for graduation for the College of Agriculture, No. 93

INTRODUCTION

Judged from the great damage it is doing to beans at the College of Agriculture, the insect which is here treated bids fair to be a pest of the first order in the growing of beans.

The bean fly was first noticed at this college in 1912 when it did great damage to beans in cultivation in that year. Previous to that time it had probably behaved in the same way but as a specific cause of the damage it had escaped notice. During January, 1917, the work of this insect was observed by the writer in a field of native cowpeas (*Vigna sinensis*) on a private farm south of the college campus. It is probable that this insect had been causing injury to native beans in this and other localities before the college was established.

This insect belongs to the order Diptera, family Agromyzidae. The family is made up of a group of very small flies, the larvae of which are largely leaf miners (1). Some, however, are known to feed upon scale insects (2), while others make galls on the twigs and leaves of certain plants. (3) The larvae of some species are also known to mine in the cambium of certain trees, the mine leaving a scar, known as "pith-ray fleck" (4).

Other species of great economic importance are reported from other countries. In Australia *Agromyza phaseoli* Coquillett (5) is said to do great damage to growing beans by mining the stem. In Ceylon, the same species is also causing serious injury, often resulting

in complete failure of the bean crop.

(6) In India, a species of *Agromyza* (7) injures the stem of peas, while in the United States, *Agromyza simplex* Loew (8) occasionally becomes destructive to asparagus by mining the stem. In a report from an entomologist in Java *Agromyza sojae* Zehnt. is described as occasionally causing no little damage to *Soja*, *Vigna* and *Phaseolus* by boring into the stem.

The bean fly of the Philippines is a new species of *Agromyza*. It was named and described by J. R. Malloch from specimens sent him from here.†

There has heretofore been no account published of this insect and its damage in other parts of the Philippines, so that the extent of its distribution in this country is still unknown. However, inspectors of the Bureau of Agriculture tell us that similar damage is observed in many places in the Philippines. In a vegetable garden inspection in the city of Manila on 1 February, 1918, by the class in Agronomy IV, the writer noticed the work of the pest on beans in two gardens, one of which is within a stone's throw northwest of the Paco railroad station and the other that of the Philippine Normal School. In the latter, adults were observed feeding and probably ovipositing on the leaves of young cowpeas (*Vigna sinensis*) and on young kidney beans (*Phaseolus vulgaris*).

The following observations on this insect were made at the College of Agriculture, Los Baños.

CHARACTER OF INJURY TO YOUNG BEANS

The adult flies are most abundant at the time of appearance of the first

* *Agromyza destructor* Malloch.

(See Bibliography at the end of this paper).

† Proceedings of the Entomological Society of Washington, (1916) 18: 93.

two leaves of the plants. The female punctures the leaves and deposits her eggs in these punctures. The punctures are whitish in appearance and are generally more plentiful near the base of the leaves. As the leaves grow, some of these punctures result in small holes.

Upon hatching, the maggots mine under the epidermis on the lower sides of the leaves. The mines are silvery in appearance due to the air layer within and the reflection of the light, and, being minute, they can be detected only upon close examination. Fig. 1, plate V, is a leaf of cowpea showing mines on the lower surface. Mines are occasionally observed on the upper epidermis of the leaves and they differ from those on the lower by being frequently wider, yellowish and usually short and broken. They are short and broken because of the fact that the maggot mines for a time and then returns mining under the lower surface again. Mines on the upper surface of the leaf are shown in Plate V, Fig. 2.

The larva is transparent and measures about three millimeters when full grown. Its mouth is armed with a strongly chitinized hook armature with which it tears the tissue. This organ is used in much the same way as a hoe, portions of the tissue being scraped with every stroke. The movement of the armature may be clearly observed by placing a leaf containing larvae under the microscope. The excreta of the larva are dark green and may be seen at intervals in the mines.

In from one to two days after hatching the larvae begin to go down the stalk, feeding just under its skin. The mines increase gradually in width as the larva grows and can easily be recognized, being whitish at first and later

become rusty in appearance. Plate III, Fig. 1 and 3 show mines on the stems. The mines are especially prominent in the kidney beans (*Phaseolus vulgaris*) and on Lima beans (*Phaseolus lunatus*).

The maggots, gradually assembling after their journey down the petioles from the respective leaves, operate more abundantly near the base of the stalks just above and below the surface of the ground. The attack causes the tissue to decay and when the entire base of the plant is involved, wilting ensues and death eventually results. The mines are frequently so abundant at the base of the stalk as to cause the entire skin to dry, resulting in a characteristic rusty appearance.

The habit of the larvae of working more abundantly at the bases of the stalks has a decidedly weakening effect on some plants causing the latter, as they grow, to break in that region.

The attack also causes the petioles of the leaves and some parts of the stem affected to swell and rupture. The swellings and ruptures in many instances appear very much like galls. The petioles of some leaves are so badly damaged as to cause the latter to wilt and die. Upon cutting these petioles open, it will be found that the inner portion is tunneled and the tissue partially decayed.

Among plants that survive the attack of the maggots when they are young, there are some which later decay at the base and die. This condition obtains especially during periods of frequent daily rains and has been observed particularly with cowpeas (*Vigna sinensis*) even during the time of flowering and fruiting.

Another effect of the injury by the maggots if they be present in large numbers is the stunting of the growth

of the plants. In stunted plants the larvae mine almost the entire stalk as well as the petioles, causing them to swell and rupture.

In young plants, the larvae pupate most frequently at the base of the stalks under the dried skin. Some of the pupae can very often be located under the dried skin by means of the swelling formed by them.

PREVIOUS VIEWS CONCERNING INJURY BY THE PEST

Before the work represented in this paper was undertaken, it was the common belief that the larvae entered the stem near or under the surface of the ground. In addition to this, it was also thought that the eggs were laid on or close to the roots and that the resulting maggots caused the death of the plants by damaging the parts just mentioned. Because of these latter beliefs the larva has been erroneously called the "legume-root maggot," and it was even suggested that, as a means of control, the deposition of eggs might be prevented by covering the soil around the stem of the plant with a circular paper of about two inches diameter and with a hole in the middle fitting the stalk. This method of control was, of course, suggested only to be used in the case of small patches of a few plants.

CHARACTER OF INJURY IN MATURE PLANTS

In mature cowpeas and kidney beans the attack is chiefly confined to the petioles of the leaves. Rarely do the larvae damage the stem and even then this does not cause the death of the plants but only produces occasional swellings. Therefore, serious damage is wrought only when the plants are young. As is the case with young plants, the attacks on the mature ones

causes the petioles of the leaves to swell and rupture. Wilting of the leaves may result from these injuries, if the attack be severe.

SIGNS OF ATTACK

From what has been said, the infestation of beans by the maggots may be indicated by the followings symptoms:

1. Presence of punctures and mines on the lower surface of the leaves, the former being whitish and the latter silvery in appearance.
2. Presence of punctures and mines on the stems the color of which may be either whitish or rusty.
3. Rusty appearance of the base of the stem due to the drying of the skin.
4. Swelling and rupturing of the petioles and stalks.
5. Wilting of some of the leaves.
6. Wilting and drying of the plants.

EXTENT OF INJURY TO YOUNG BEANS

In studying the extent of the damage done to young beans by this pest, the following points were considered:

- (a) Total number of plants.
- (b) Number of plants infested.
- (c) Number of plants that die.
- (d) Number of plants that survive.

The flies show preference for the kidney bean (*Phaseolus vulgaris*) and the cowpea (*Vigna sinensis*). It is hardly possible to find in this locality a field of these beans which is not completely infested by the maggots. In some pole varieties of the former species, as the Kentucky Wonder and the Southern Crease Back, the flies breed freely in the petioles of the mature plants, as well as in the petioles and stalks of the young ones. The leaves of cowpeas are punctured in all stages of the growth of the plants. However, unlike the attack on the kidney beans, the flies do not breed freely in the petioles of the mature plants.

The accompanying tables, I to IX, give an idea as to the extent of injury to young beans by this pest. Table I is a record of the damage during April, 1916, in a planting of kidney and Lima beans in the rice paddies north of the Botany Laboratory. The table shows that the infestation was 100 per cent with the exception of the Imperial Bush Lima (4959 F₁) in which 35 out of 53 plants were infested, giving 66 per cent infestation. It is further seen that except in the case of the Lima, the damage was 100 per cent in every case.

Table II gives a record of the damage during May, 1916, in a field east of the Temporary Building. Without taking the immune species into account the infestation in every case was 100 per cent. The damage to the kidney beans ranged from none in the case of the Triumph Bush Bean (2162 F₂) to 74 per cent in the case of the Southern Prolific Pole Beans (4769 F₁), the average being 44 per cent. The damage to the Lima Beans was from none to 25 per cent or an average of 11 per cent.

The injury to cowpeas which were planted during May, 1916, in the triangular orchard between the Agronomy Building and the Tobacco House is shown in Table II. All of the plants were infested and the loss was from 32 to 80 per cent—an average of 56 per cent for each row—a figure which may be considered as the average for the entire field. It may be remarked in this connection that in June it was found necessary to replant the vacant hills in this field.

During June of the same year the destruction of cowpeas in a field east of the road leading to the Students' Chapel averaged 6 per cent. This is shown in Table IV.

Table V gives a record of the damage during July, 1916, to beans which were planted in the acclimatization plots. The loss in the case of *Dolichos lablab* L. was from 11 to 30 per cent, or an average of 23 per cent; while in that of the Limas the loss ranged from none to 11 per cent, or an average of 4 per cent. Excepting the immune beans, the infestation was 100 per cent.

Tables VI and VII show the injury during September. In the former table the damage to the kidney beans was from 50 to 83 per cent. While the infestation was 100 per cent in both the Limas and the Tepary, there was practically no plant which succumbed to the attack. The loss in the case of the cowpeas, as shown in Table VII, was insignificant, averaging only about 2 per cent.

The amount of damage to cowpeas during December, 1916, in the Citrus Orchard is shown in Table VIII. The cowpeas were planted in rows between the citrus trees and were intended for green manure. All of the plants were infested and the average loss for the whole field was 49 per cent.

During February, 1918, the damage to cowpeas in a field east of the road to the Students' Chapel was 70 per cent. In an adjacent field of the same kind of plants the loss was practically 100 per cent. The vacant hills in the former field were replanted on the 23rd of February and at this writing the plants are again infested as indicated by the numerous punctures and mines on the leaves.

According to the above data, it is seen that the pest does the most damage to the kidney beans and the cowpeas, 100 per cent injury having been recorded for each. It is further seen that the infestation was practically 100 per cent in every case. As stated elsewhere in this paper, an individual female

fly is capable of laying from 113 to 330 eggs, or an average of 199. Under the same heading, it is stated that the fly distributes her eggs in all of the plants accessible to her. These facts undoubtedly account for this complete infestation.

The flies breed freely in volunteer beans, as observed during February, 1917, with cowpeas in the citrus plantation. The plants grew from seeds dropped in the harvesting of the crop from the cowpea plants indicated in Table VIII.

RESISTANT SPECIES AND VARIETIES OF BEANS

The Limas and the patanis, both belonging to the same species (*Phaseo-*

lus lunatus), are the most resistant beans observed in any season by the writer. In addition to this, they are only attacked at the time of appearance of the first two leaves. Batao (*Dolichos lablab*) and the mungos (*Phaseolus mungo*) in general are also resistant but not to the same degree as the Limas and the patanis. Like the last two, they are only attacked when the first two leaves appear.

The cowpeas resist the attack well during the rainy season. This is due to the presence of enough moisture to enable them to grow rapidly. It may be remarked, however, that cowpeas grown during the rainy season will produce heavy vegetation but bear but few pods.

TABLE I

BEANS IN RICE PADDIES NORTH OF THE BOTANY LABORATORY.—PLANTED 24 MARCH, 1916

College No.	Name	No. of rows	Total No. of plants	No. infested	No. killed	No. survived	Percentage damage
4960F ₁	Lima, King of the Garden.....	1	46	46	26	20	56
4959F ₁	Imperial Bush Lima.....	1	53	35	24	29	45
4685F ₁	Kentucky Wonder.....	1	49	49	49	0	100
4570F ₁	Hodson Green Pod.....	1	24	24	24	0	100
4770	Horticultural Pole Bean.....	1	35	35	35	0	100
4571F ₁	White Mexican.....	1	69	69	69	0	100
4700	Black Valentine.....	1	79	79	79	0	100
4953	Lady Washington.....	1	38	38	38	0	100
4687	Long Yellow Six Weeks.....	1	62	62	62	0	100
4769	Souther Prolific.....	1	42	42	42	0	100
4969	Dwarf Horticultural.....	1	18	18	18	0	100
4946	French Mohawk.....	1	46	46	46	0	100
4938	Mexican Pink.....	1	65	65	65	0	100
4937	Prolific Black Wax.....	1	69	69	69	0	100
	Canadian Wonder.....	1	70	70	70	0	100
4701	Thorburn Extra Early.....	1	55	55	55	0	100

NOTE:—Beans from 4685 to 4701 are kidney beans, *Phaseolus vulgaris*.

THE BEAN FLY

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TABLE II

BEANS EAST OF TEMPORARY BUILDING. PLANTED 11 MAY, 1916

College No.	Name	No. of rows	Total No. of plants	No. infested	No. killed	No. survived	Percentage damage
4570F ₁	Hodson Green Pod Beans.....	2	61	61	39	22	64
4700F ₁	Black Valentine Beans.....	1	46	46	25	21	55
3405F ₁	Kentucky Wonder Wax.....	1	44	44	28	16	64
2112F ₂	Runner Bean.....	1	40	40	10	30	25
2156	Bush Beans.....	1	9	9	5	4	56
4686F ₁	Round Yellow Six Weeks.....	1	67	67	9	58	13
3404F ₁	Golden Wax.....	1	62	62	2	60	3
2108	Runner Beans.....	1	76	76	16	60	21
2156F ₂	Bush Beans Flageolet.....	1	49	49	11	38	22
2162F ₂	Bush Beans Triumph.....	1	37	37	0	37	0
4570F ₁	Hodson Green Pods.....	1	83	83	30	53	36
2143F ₂	Bush Beans Erfurt.....	1	42	42	9	33	21
1512F ₂	Phaseolus vulgaris, Bombay....	1	71	71	22	49	31
4953F ₁	Lady Washington.....	1	65	65	44	21	68
3647	Soy Beans.....	1	80	Immune Immune		....	....
2142F ₁	Bush Beans Wax.....	....	....	....	....	....	....
	Parisian.....	2	92	92	34	58	37
2129F ₂	Bush Beans Orborus.....	1	25	25	11	14	44
2144F ₁	Bush Beans Hundred to One....	1	20	20	2	18	10
4701F ₁	Thorburn Extra Early.....	1	82	82	43	39	53
4946	Beans French Mohawk.....	1	92	92	45	47	49
3412F ₁	Beans Mohawk.....	1	110	110	29	81	26
4685F ₁	Kentucky Wonder.....	1	117	117	63	55	53
2162F ₁	Bush Beans Triumph.....	1	56	56	14	42	25
1512F ₁	Phaseolus vulgaris from Bombay	1	126	126	63	63	50
2137F ₂	Bush Beans Wacho Dotte.....	1	58	58	36	22	62
4970F ₁	Horticultural Pole Beans.....	1	44	44	10	34	23
4960	Lima, King of the Garden.....	1	47	47	1	46	2
4686	Round Yellow Six Weeks.....	1	99	99	35	64	35
4938F ₁	Mexican Pink.....	1	58	58	33	25	57
3407F ₁	Bush Lima.....	1	95	95	24	71	25
4699F ₁	Southern Crease Back.....	1	124	124	66	58	53
4952F ₁	Challenger's Lima.....	1	36	36	6	30	17
4571F ₁	Michigan White Wax.....	1	113	113	69	44	61
4948F ₁	Canadian Wonder.....	1	108	108	61	47	56
5845	Wester Bean.....	1	125	125	17	108	14
4769F ₁	Southern Prolific Pole Beans....	1	104	104	77	27	74
214F ₁	Patani (Phaseolus lunatus)....	1	78	78	0	78	0
496F ₁	Stizolobium lyoni (Velvet Bean.)	3	287	Immune Immune		....	....
4688F ₁	Extra Early Valentine.....	1	49	49	29	20	59
4698	Long Yellow Six Weeks.....	1	76	76	37	39	49
3410	Beans Extra Early Refugee....	1	55	55	33	22	60
207F ₁	Calamismis (Psophocarpus te- tragonolobus).....	1	79	Immune Immune		....	....
5846	Canavalia ensiformis.....	1	87	Immune		....	....
5809	Canavalia ensiformis.....	1	56	Immune		....	....
5818	Cajanus indicus.....	1	39	Immune		....	....
5812	Cajanus indicus.....	1	82	Immune		....	....
5808	Cajanus indicus.....	1	30	Immune		....	....
	Volunteer Soy Beans.....	....	884	Immune		....	....

TABLE III

COWPEAS IN TRIANGULAR ORCHARD. PLANTED
9 MAY, 1916

Row No.	Total No. of plants	No. infested	No. killed	No. survived	Percentage of damage
1	364	All	145	219	40
2	293	"	130	163	44
3	294	"	167	127	57
4	302	"	203	99	67
5	181	"	78	103	43
6	391	"	190	201	49
7	177	"	75	102	43
8	145	"	51	94	35
9	132	"	71	61	53
10	97	"	31	66	32
11	144	"	91	53	63
12	113	"	61	52	54
13	153	"	77	76	50
14	78	"	48	30	61
15	131	"	70	61	54
16	146	"	89	57	61
17	87	"	57	30	66
18	107	"	86	21	80
19	77	"	44	33	57
20	100	"	69	31	69
21	65	"	40	25	62
22	92	"	51	41	55
23	87	"	63	24	72
24	60	"	38	22	63
25	64	"	35	29	55

26	68	"	42	26	62
27	74	"	41	33	55
28	49	"	29	20	59
29	41	"	28	13	68
30	56	"	38	18	68

Average

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TABLE IV

COWPEAS EAST OF THE ROAD TO STUDENTS'
CHAPEL. PLANTED 24 MAY, 1916

Row No.	Total No. of plants	No. infested	No. killed	No. survived	Percentage of damage
1	265	All	24	241	9
2	277	"	9	268	3
3	306	"	14	292	5
4	263	"	10	253	4
5	352	"	15	337	4
6	405	"	22	383	5
7	383	"	11	372	3
8	292	"	8	284	3
9	426	"	18	408	4
10	342	"	23	319	7
11	313	"	26	287	8
12	365	"	22	343	6
13	287	"	27	260	9
14	337	"	22	315	7
15	276	"	33	243	12

TABLE V

BEANS IN ACCLIMATIZATION PLOTS. PLANTED 13 JULY, 1916

College No.	Name of Bean	No. of rows	No. of plants	No. infested	No. killed	No. survived	Percentage of damage
5947	Dolichos lablab.....	5	128	128	34	94	27
5951	Stizolobium lyoni.....	6	104	Immune			
5951	Stizolobium lyoni.....	5	128	Immune			
5953	Canavalia ensiformis.....		46	Immune			
5949	Dolichos lablab.....	6	184	184	55	129	30
5948	Dolichos lablab.....		173	173	19	154	11
5943	Phaseolus lunatus.....		185	185	4	181	2
5945	Lima bean (P. lunatus).....	6	201	201	2	199	1
5942	Sugar bean (P. lunatus).....	6	115	115	13	102	11
5944	Phaseolus lunatus.....	6	192	192	0	192	0

TABLE VI

BEANS IN GARDEN EAST OF THE ROAD TO STUDENTS' CHURCH

Date planted	College No.	Name	No. of rows	No. of plants	No. infested	No. killed	No. survived	Percentage of damage
25-VIII-1916.....		Indian Lima.....	7	84	84	0	84	0
25-VIII-1916.....		Tepary.....		86	86	2	84	2
25-VIII-1916.....	4685F ₂	Kentucky Wonder.....	6	167	167	84	83	50
1- IX-1916.....	4699F ₂	Southern Crease Back.....	6	178	178	148	30	83
8- IX-1916.....	4769F ₂	Southern Prolific.....	5	83	83	46	37	55
8- IX-1916.....		Kentucky Wonder.....		129	129	90	39	70
8- IX-1916.....		Bush Lima.....	7	288	288	4	244	1

TABLE VII

COWPEAS EAST OF ENGINEERING LABORATORY
PLANTED SEPT. 1916

Row No.	Total No. of plants	No. infested	No. of plants killed	No. of plants survived	Percentage of damage
1	219	All	5	214	2
2	212	"	0	212	0
3	134	"	4	130	3
4	314	"	5	209	2
5	295	"	7	288	2
6	331	"	5	326	2
7	322	"	0	322	0
8	303	"	7	296	2

TABLE VIII

COWPEAS IN CITRUS PLANTATION DECEMBER, 1916

Row No.	No. of plants	No. infested	No. killed	No. survived	Percentage of damage
1	252	All	110	142	44
2	196	"	93	103	47
3	145	"	61	84	42
4	154	"	62	92	40
5	129	"	66	63	51
6	190	"	68	122	35
7	162	"	83	79	51
8	140	"	64	76	46
9	146	"	71	75	48
10	141	"	69	72	49
11	118	"	51	67	43
12	228	"	69	159	30
13	170	"	72	98	42
14	109	"	48	61	44
15	190	"	54	136	28
16	150	"	53	97	35
15	118	"	68	50	57
18	140	"	61	79	43
19	132	"	59	73	44
20	101	"	57	44	56
21	127	"	54	73	42
22	181	"	78	103	43
23	203	"	83	120	40
24	202	"	118	84	58
25	259	"	125	134	48
26	200	"	120	80	60
27	263	"	136	127	52
28	263	"	144	119	54
29	253	"	162	91	64
30	306	"	151	155	49
31	176	"	105	71	59
32	136	"	114	22	83
33	152	"	86	66	56
34	143	"	89	54	60
35	139	"	108	31	77
36	165	"	110	55	66
37	168	"	102	66	60
38	174	"	73	101	41
39	179	"	76	103	42
40	107	"	39	68	36
41	90	"	34	56	38
42	142	"	46	96	32
43	119	"	48	71	40
44	32	"	26	6	81
45	88	"	54	34	61
46	68	"	33	35	48
47	83	"	48	35	57
48	88	"	41	47	46
49	146	"	59	87	40
50	117	"	29	88	24
51	186	"	61	125	32
52	138	"	47	91	34

IMMUNE BEANS

As far as observed, the following beans are immune to the attack of the pest:—*Psophocarpus tetragonolobus* (Calamismis), *Centrosema plumieri*, *Canavalia ensiformis*, *Cyamopsis psoraloides* (Guar), *Stizolobium lyoni* (Velvet bean), *Glycine hispida* (Soy bean), and *Cajanus indicus* (Caguios).

DEGREE OF ABUNDANCE AND SEASON OF
GREATEST DESTRUCTIVENESS

The author has invariably observed the flies abundant wherever young beans of susceptible varieties or species are growing. From this it may be inferred that they are present in the same degree of abundance throughout the year.

In this locality the pest does the most damage from January to April, inclusive. This period may be considered as the worst maggot-season. It would be a waste of seeds, time, and labor to plant cowpeas and kidney beans during these months as the plants will have little chance to survive. The plants may survive the attack of the maggots but their growth will be stunted and they will produce few or no pods. The stunting is, of course, partially due to the dry weather, but the two factors are so strong as to leave little chance for even the survival of the plants, to say nothing of seed production.

On the other hand, cowpeas and kidney beans grown during the rainy season will produce heavy vegetation but will bear few pods, and in the case of the kidney beans, the pods are very susceptible to decay.

The best time to plant cowpeas and kidney beans in this locality is during October and November. During these months the moisture is just enough to cause the plants to grow rapidly at the start, a condition which enables the plants to resist the effects of maggot infestation.

DESCRIPTIONS

The Egg

Milky white, translucent and perfectly smooth. It is ellipsoidal, but slightly broader near the posterior end. At the anterior extremity is a characteristic small protuberance. The microscope reveals no reticulation of the chorion. The length varies from 0.3 to 0.33 millimeters and the greatest diameter from 0.12 to 0.16 millimeter, the average being 0.32 and 0.14 millimeter respectively. The egg enlarged is shown in Plate I, Fig. 2.

The egg usually hatches in two days but may hatch in three, as records during August, September, October, 1917, and February 1918 show.

The Larva

The full grown larva measures from 2.5 to 3 millimeters in length and from 0.6 to 0.8 millimeter in its greatest diameter. It is pale yellow, smooth, shiny, and slightly arched dorsad, composed of 13 segments and tapers cephalad. From the anterior extremity to about one third the length, the diameter increases and from there gradually decreases caudad, terminating broadly. The anterior and posterior pairs of spiracles are yellow, and extruded. The latter are more prominent than the former. The anterior spiracles are situated on the dorsal posterior portion of the third segment (second thoracic) from the cephalic end. On the ventral portion of the anal segment is a sucker-like organ almost circular in outline and equally divided into two by a groove which runs along the median line. The mouth is provided with a black retractile and strongly chitinized hook or buccal armature, which consists of two teeth the anterior one being more prominent, sharp-pointed and curved. The hook is shown in Plate I, Figs. 4 and 5 Just dorsad

of the armature is a vermiform projection. This organ is transparent and is club-shaped.

When ready to pupate, the larva remains quiescent, contracts in length and increases in diameter.

First Instar

The newly hatched larva measures about 0.33 mm. in length and 0.12 mm. in its greatest width. It is white, transparent and the shape is like that of the full grown larva. The segments are obscurely defined. The vermiform protuberance dorsad of the armature is not yet apparent. The anterior and posterior spiracles are not yet visible. The buccal armature is black-brown and consists of three teeth, the anterior and middle ones being sharp-pointed and of about the same length. The posterior tooth is rudimentary. The first instar is shown in Plate I, Fig. 3. Plate I, Fig. 4 shows the armature of the first instar.

Second Instar

The larva molts after two days and becomes 1 millimeter in length and 0.24 millimeter in its greatest diameter. It is transparent, white and the segments become more clearly defined. The posterior spiracles are now visible; likewise, the vermiform projection above the buccal armature appears. The anterior spiracles are still not visible. The armature becomes black and its anterior tooth disappears. The armature of the second instar is shown in Plate I, Fig. 5.

Third Instar

The second molt takes place after two or three days and the larva becomes 1.4 mm. long and 0.3 mm. in its greatest diameter. The body segments, as well as the vermiform appendage and the posterior spiracles, become more prominent. The anterior spiracles are now visible.

The armature is like that of the preceding instar.

Plate I, Fig. 7 shows the third instar.

The larva becomes less transparent as its development progresses.

The Puparium

Oblong, surface smooth and shiny, brownish yellow, except the first two anterior segments, including the anterior spiracles, which are black. The posterior spiracles are also black, except at the extreme tip, which is pale yellow. The anterior and posterior pairs of spiracles are prominent, the former being the smaller. There are twelve segments visible, those on the extremities being the smallest. On the ventral portion of the anal segment is an opening the border of which is dark. The pupa is convex dorsad, somewhat flattened and sometimes slightly concave ventrad. The segments are well defined and the articulations consist of bands granular in appearance.

When newly transformed the puparium is pale yellow, becoming black a day or two before the imago emerges.

The puparium is shown in Plate I, Figs. 9 and 10.

The Adult

Malloch's description of the adult with introductory remarks is as follows, copied from the Proceedings of the Entomological Society of Washington, reference to which has been made previously in this paper.

"A NEW SPECIES OF AGROMYZA DESTRUCTIVE TO BEANS IN THE PHILIPPINES

By J. R. MALLOCH, *Urbana, Illinois.*

"This species was sent me by Professor Baker with the information that it is very destructive to beans in the Philippines. It works in the stems of young plants and sometimes destroys whole fields. In a later letter he adds

the information that it "often causes extensive damage in planting of cowpeas, mungo, and beans." The following description is printed, as a name is desired for the species.

Agromyza destructor, new species.

"Female.—Shining black. Head entirely black, center stripe opaque, orbits and frontal triangle glossy black, with a bluish tinge. Thorax and abdomen with a slight tinge of blue. Legs entirely black. Wings clear, veins black-brown. Halteres black.

"Frons slightly over one-third the head width, sides distinctly convergent anteriorly, the anterior width little more than half the posterior width; triangle very long and slender, its length about twice its posterior width, reaching almost to anterior margins of frons; orbital bristles 4 in number, decreasing slightly in length towards front; orbits narrow, distinctly differentiated from center stripe, without distinct hairs; third antennal joint small, round; arista bare; cheek short, not over one-sixth the eye-height not produced anteriorly, marginal hairs normal. Mesonotum with 2 pairs of dorso-centrals, discal setulae not numerous. Costa to end of fourth vein; inner cross-vein below end of first, and at two-fifths from apex of discal cell; last section of fourth vein about five times as long as preceding section; last section of fifth about two-thirds as long as preceding section.

"Length, 0.5-0.75 mm.

"Type locality: Los Baños, Philippine Islands (C. F. Baker)."

The adult which is light brown at emergence, is active and its wings are folded, remaining in this condition for about five minutes. The wing as folded is shown in Plate II Fig. 13. The fly assumes its natural color (black) in about one hour. Just after emergence the white bladder-like ptilinum, which is constantly expanded and contracted, may be seen. The ptilinum when expanded is shown in Plate 2 Fig. 1. This organ serves the fly for three purposes:

(a) To break the pupal skin, (b) to rupture the bean skin and (c) to enable it to force its way out of the soil. The movement of the ptilinum may be ob-

served by putting pupae in a vial and plugging the latter with cotton. The imago upon emergence forces itself out between the glass and the cotton.

The adults, when disturbed, make a quick flight. They are generally more active between 4 and 6 o'clock in the afternoon. The writer has invariably found it more difficult to catch specimens between these hours than at any other hours of the day. Specimens can easily be obtained alive by using a good-sized vial for their capture.

Malloch gives 0.5 to 0.75 millimeter as the length of the female. This measurement does not agree with any taken here, as will be seen from the tables given below. This is apparently an error due perhaps to the great shrinkage of the specimens sent him from here. Measurements of 50 fresh specimens consisting of 25 males and 25 females gave the following results:

No.	Males Length mm.	No.	Females Length mm.
1.....	1.5	1.....	1.8
2.....	1.5	2.....	2.0
3.....	1.5	3.....	1.6
4.....	1.8	4.....	1.5
5.....	1.2	5.....	2.0
6.....	1.0	6.....	1.4
7.....	1.0	7.....	2.0
8.....	1.5	8.....	1.6
9.....	1.2	9.....	1.8
10.....	1.0	10.....	1.5
11.....	1.4	11.....	1.8
12.....	1.4	12.....	2.0
13.....	1.5	13.....	1.7
14.....	1.4	14.....	1.5
15.....	1.2	15.....	1.7
16.....	1.2	16.....	1.5
17.....	1.0	17.....	2.0
18.....	1.4	18.....	2.0
19.....	1.2	19.....	2.0
20.....	1.3	20.....	1.8
21.....	1.2	21.....	1.8
22.....	1.2	22.....	1.8
23.....	1.5	23.....	1.8
24.....	1.2	24.....	1.6
25.....	1.2	25.....	1.8
Average length of male.....1.3		Average length of female.....1.76	

The above table shows that in the case of the males the length varies from 1 to 1.5 millimeters, while in the case of the females it ranges from 1.4 to 2 milli-

eters. The average length of the male is 1.22 mm., while that of the female 1.76.

Measurements of the same number of specimens, consisting of an equal proportion of the sexes, and which have been in the cabinet for about two months gave the following:

No.	Males Length mm.	No.	Females Length mm.
1.....	1.5	1.....	1.7
2.....	1.5	2.....	1.5
3.....	1.0	3.....	2.0
4.....	1.2	4.....	1.8
5.....	1.0	5.....	1.7
6.....	1.0	6.....	1.4
7.....	1.4	7.....	1.2
8.....	1.5	8.....	1.4
9.....	1.5	9.....	1.5
10.....	1.2	10.....	1.5
11.....	1.2	11.....	1.6
12.....	1.0	12.....	1.4
13.....	1.2	13.....	1.5
14.....	1.0	14.....	1.3
15.....	1.2	15.....	1.2
16.....	1.5	16.....	2.0
17.....	1.5	17.....	1.5
18.....	1.0	18.....	1.3
19.....	1.0	19.....	1.0
20.....	1.5	20.....	1.5
21.....	1.0	21.....	1.8
22.....	1.0	22.....	1.6
23.....	1.0	23.....	1.7
24.....	1.5	24.....	1.5
25.....	1.0	25.....	1.6
Average length of male.....1.21 mm.		Average length of female.....1.52 mm.	

The above table gives an average of 1.21 millimeters for the male and 1.52 millimeters for the female.

MATING

The flies copulate in one to four days after emergence. Copulation occurs in the morning between 7 and 10 o'clock. This is true both in the laboratory and in the field. Copulation may occur in the afternoon but is very rare. In the laboratory the writer observed, in only one instance, a pair copulating in the afternoon, and that was on March 7, 1918 at 3:20 in the afternoon.

OVIPOSITION

The female commences laying her eggs usually in one to two days after mating. The eggs are laid in punctures in the leaf. They are generally deposited under the lower epidermis.

showing egg and feeding punctures Plate I, Fig. 1 is an individual puncture enlarged with an egg *in situ*. The eggs can not be seen with the naked eye when in place. They are, however, visible after the leaf has been for some time in a preserving solution, the white being very prominent against the pale green background.

METHOD OF OVIPOSITION

In ovipositing, the fly first bends her abdomen downward and then thrusts her ovipositor into the leaf. She then moves her body slightly from side to side during which the ovipositor is put into operation under the epidermis of the leaf and an excavation is made. The egg is then placed in the puncture. Thereafter the adult steps backward and with her proboscis sucks the juice of the puncture. The whole process takes about one minute. The act of oviposition may be easily observed by putting a female, better if several, in a good-sized vial together with a fresh leaf of a young cowpea plant. The vial should be plugged with cotton to prevent as much as possible the rapid accumulation of moisture.

Not all punctures contain eggs, as the adult uses these punctures for feeding as well as for oviposition. The leaves of young beans, especially cowpeas, are often completely riddled with

these punctures, which doubtless are, in themselves, an injury to the plant.

NUMBER OF EGGS LAID

The female does not lay its eggs all at one time. Hence, dissection of any except newly emerged specimens will not give a satisfactory clue as to the total number of eggs which this species lays.

In order to secure some data with respect to the egg laying capacity of the fly, experiments were begun on 11th October, 1917. For this purpose adults reared in the laboratory were used. A bred male and female in copulation were purposely selected. Young cowpea plants (*Vigna sinensis*) grown in nursery pots were used for oviposition. The plants were inclosed by a lamp chimney, such as was used in the life history work, and the flies were turned loose inside this cage.

The flies were transferred to fresh plants every day, except in some cases where plants were not changed for two days, but not longer, so as to allow the eggs to hatch. The eggs laid in the leaf were counted, with the aid of a hand lens. Before counting, the leaves were decolorized with alcohol. However, the last operation was found necessary only when punctures were very numerous. The following tables. IX to XIII, show records of the number of eggs laid by five females:—

TABLE IX

FEMALE FLY NO. 1

EMERGED 6 OCTOBER, 1917. MALE AND FEMALE IN COPULA 9 OCTOBER, 1917

Day	Date	No. of eggs laid	No. of plants used	Distribution of eggs in leaves					
				I	II	III	IV	V	VI
1st day.....	11- X-1917.....	9	..	..	..	..	..	..	..
2nd day.....	12- X-1917.....	13	..	..	..	..	..	..	..
3rd day.....	13- X-1917.....	30	3	3	5	5	5	5	7
4th day.....	14- X-1917.....	26	2	5	10	5	6	..	..
5th day.....	15- X-1917.....	19	3	7	4	2	2	3	1
6th day.....	16- X-1917.....	16	3	8	2	2	1	1	2
7th day.....	17- X-1917.....	0	..	..	..	..	..	..	..
8th day.....	18- X-1917.....	0	..	..	..	..	..	..	..
9th day.....	19- X-1917.....	Female died.							
Total number of eggs laid.....		113	..	..	..	..	..	..	..

TABLE X
FEMALE FLY NO. 2
EMERGED 16 OCTOBER, 1917. MALE AND FEMALE IN COPULA 18 OCTOBER, 1917

Day	Date	No. of eggs laid	No. of plants used	Distribution of eggs in leaves					
				I	II	III Leaf No.	IV	V	VI
1st day	19- X-1917	7	..	..	..	..	..	..	..
2nd day	20- X-1917	..	..	..	..	..	..	..	..
3rd day	21- X-1917	34	3	8	6	2	0	13	5
4th day	22- X-1917	38	3	1	2	8	4	4	19
5th day	23- X-1917	32	2	21	0	4	7	..	..
6th day	24- X-1917	37	3	8	9	8	7	5	0
7th day	25- X-1917	24	3	8	4	5	5	2	0
8th day	26- X-1917	1	2	1	0	0	0	..	0
9th day	27- X-1917	24	3	5	10	3	5	1	..
10th day	28- X-1917	15	1	8	7	..	..	..	..
11th day	29- X-1917	16	3	5	3	3	0	2	3
12th day	30- X-1917	24	3	5	1	5	5	6	2
13th day	31- X-1917	18	2	13	2	3	0	male died	
14th day	1-XI-1917	..	..	..	..	..	..	..	..
15th day	2-XI-1917	33	2	9	8	9	7	..	..
16th day	3-XI-1917	14	1	9	5	..	..	..	..
17th day	4-XI-1917	3	1	0	3	..	..	..	..
18th day	5-XI-1917	10	2	6	2	2	0	..	..
19th day	6-XI-1917	0	..	..	..	..	..	..	..
20th day	7-XI-1917	0	..	..	..	..	..	..	..
21st day	8-XI-1917	Female died.							
Total number of eggs laid		330	..	..	..	..	..	..	..

TABLE XI
FEMALE FLY NO. 3
EMERGED 18 OCTOBER, 1917. MALE AND FEMALE IN COPULA 20 OCTOBER, 1917

Day	Date	No. of eggs laid	No. of plants used	Distribution of eggs in leaves					
				I	II	III Leaf No.	IV	V	VI
1st day....	28- X-1917.....	Put in cage							
2nd day....	29- X-1917.....	4	3	1	1	1	0	1	0
3rd day....	30- X-1917.....	24	2	12	9	0	3	..	..
4th day....	31- X-1917.....	17	3	2	1	0	1	8	5
5th day....	1-XI-1917.....	..	..	..	..	..	..	..	..
6th day....	2-XI-1917.....	26	3	5	5	11	4	1	0
7th day....	3-XI-1917.....	16	3	9	5	2	0	0	0
8th day....	4-XI-1917.....	21	3	5	3	8	3	2	0
9th day....	5-XI-1917.....	14	2	6	4	4	0	..	..
10th day....	6-XI-1917.....	19	3	7	3	2	3	3	1
11th day....	7-XI-1917.....	14	2	4	6	3	1	..	..
12th day....	8-XI-1917.....	5	2	3	1	1	0	..	..
13th day....	9-XI-1917.....	0	..	..	..	..	..	..	..
14th day....	10-XI-1917.....	0	..	..	..	..	..	..	..
15th day....	11-XI-1917.....	0	..	..	..	..	..	..	..
16th day....	12-XI-1917.....	0	..	..	..	..	..	..	..
17th day....	13-XI-1917.....	Female died.							
Total number of eggs laid....		160	..	..	..	..	..	..	..

TABLE XII
FEMALE FLY NO. 4

Day	Date	No. of eggs laid	No. of plants used	Distribution of eggs in leaves Leaf No.					
				I	II	III	IV	V	VI
1st day....	6-XI-1917.....	Male & Female in copula.							
2nd day....	7-XI-1917.....	17	2	8	3		3	..	..
3rd day....	8-XI-1917.....	..	..	..	..	..	..	..	..
4th day....	9-XI-1917.....	10	2	4	4	1	1	..	..
5th day....	10-XI-1917.....	19	3	3	5	6	2	3	0
6th day....	11-XI-1917.....	25	2	11	4	4	6	..	..
7th day....	12-XI-1917.....	18	2	13	2	3	0	..	..
8th day....	13-XI-1917.....	27	3	5	8	7	4	2	1
9th day....	14-XI-1917.....	20	3	2	6	4	3	2	3
10th day....	15-XI-1917.....	27	2	4	6	7	10	..	..
11th day....	16-XI-1917.....	3	..	..	..	..	..	..	..
12th day....	17-XI-1917.....	Female died.							
Total number of eggs laid.....		166	..	..	..	..	..	..	..

TABLE XIII
FEMALE FLY NO. 5
EMERGED 16 NOVEMBER, 1917. MALE AND FEMALE IN COPULA 18 NOVEMBER, 1917

Day	Date	No. of eggs laid	No. of plants used	Distribution of eggs in leaves					
				I	II	Leaf No. III	IV	V	VI
1st day....	19- XI-1917.....	15	3	3	5	1	2	2	2
2nd day....	20- XI-1917.....	29	3	9	5	3	2	5	5
3rd day....	21- XI-1917.....	23	3	7	3	8	2	2	1
4th day....	22- XI-1917.....	17	2	5	8	4	0	..	..
5th day....	23- XI-1917.....	22	3	3	7	4	6	2	0
6th day....	24- XI-1917.....	27	2	10	3	8	6	..	..
7th day....	25- XI-1917.....	16	3	9	3	2	0	2	0
8th day....	26- XI-1917.....	21	2	2	8	6	5	..	..
9th day....	27- XI-1917.....	23	3	4	3	2	7	7 male died	..
10th day....	28- XI-1917.....	18	2	3	10	2	3	..	..
11th day....	29- XI-1917.....	11	1	7	4	..	..	..	..
12th day....	30- XI-1917.....	7	3	0	0	3	0	2	2
13th day....	1-XII-1917.....	Female died.							
Total number of eggs laid....		229	..	..	..	..	..	..	..

In the foregoing tables it is seen that the number of eggs laid varies from 113 to 330, the average being 199. It is further seen that the eggs are not all laid in one leaf nor in a single plant but are distributed in all the leaves of the plants.

LONGEVITY

In the study of the longevity of the flies, vials varying in height from 4 to 10 centimeters and from 2 to 3

centimeters in diameter were used. Cotton plugs were used as stoppers, so that the flies could be supplied with air. In each vial was placed a piece of tough paper which served as a label. Honey was used to feed the flies and this was put in small drops on the paper label by means of sharp pointed sticks.

Table XIV is a record of the longevity of 12 males and 12 females allowed to dwell separately. In this table

it is seen that the longevity of the female ranges from 27 to 60 days, while that of the male ranges from 16 to 49 days. These figures give an average of 38 days for the female and 37 days for the male.

The longevity of the sexes when kept together is shown in Table XV. According to this table, the average longevity of the male is 22 days and of the female, 27 days. Comparing these

figures with the averages obtained in Table XIV, it would appear that the life of the sexes is considerably shortened when they are put together.

Tables XIV and XV show that the female lives for a considerably longer time than the male, the highest record for the female being 62 days and the male 51 days.

The adults die in 2 to 4 days when not given food.

TABLE XIV
LONGEVITY FEMALE

<i>Vial No.</i>	<i>No. of individuals</i>	<i>Emerged</i>	<i>Died</i>	<i>Longevity days</i>
1	1	10- X-1917.....	3-XII-1917.....	54
2	1	22- X-1917.....	22- XI-1917.....	31
3	1	22- X-1917.....	24- XI-1917.....	33
4	1	22- X-1917.....	14- XI-1917.....	23
5	1	22- X-1917.....	18- XI-1917.....	27
6	1	22- X-1917.....	25- XI-1917.....	34
7	1	22- X-1917.....	22- XI-1917.....	31
8	1	6-XI-1917.....	25-XII-1917.....	49
9	1	16-XI-1917.....	6- I-1918.....	51
10	1	30-XI-1917.....	3- I-1918.....	34
11	1	30-XI-1917.....	3- I-1918.....	34
12	1	30-XI-1917.....	29- I-1918.....	60
			Average.....	38

MALE

<i>Vial No.</i>	<i>No. of individuals</i>	<i>Emerged</i>	<i>Died</i>	<i>Longevity days</i>
1	1	1-IX-1917.....	20- X-1917.....	49
2	5	6- X-1917.....	2 died 14- XI-1917.....	39
			2 died 15- XI-1917.....	40
			1 died 18- XI-1917.....	43
3	1	15- X-1917.....	24- XI-1917.....	40
4	2	16- X-1917.....	30- XI-1917.....	44
5	2	16- X-1917.....	1 died 14-XI-1917.....	29
			Others died 22-XI-1917.....	37
6	1	30-XI-1917.....	16-XII-1917.....	16
			Average.....	37

TABLE XV
LONGEVITY
MALE AND FEMALE CONFINED TOGETHER

No. of individuals		Emerg'd	Died		Longevity—days	
Males	Females		Male	Female	Male	Female
1	1	10- X-1917.....	30- XI-1917.....	11-XII-1917.....	51	62
2	3	6-XI-1917.....	23- XI-1917.....	25- XI-1917.....	17	19
			3-XII-1917.....	30 XI-1917.....	27	24
				30- XI-1917.....		24
1	1	16-XI-1917.....	29- XI-1917.....	4-XII-1917.....	13	18
1	1	16-XI-1917.....	3-XII-1917.....	6-XII-1917.....	17	20
1	1	16-XI-1917.....	23-XII-1917.....	3-XII-1917.....	37	17
1	1	16-XI-1917.....	9-XII-1917.....	23-XII-1917.....	23	37
1	1	16-XI-1917.....	30- XI-1917.....	8-XII-1917.....	14	22
1	1	19-XI-1917.....	30- XI-1917.....	27-XII-1917.....	11	38
1	1	30-XI-1917.....	18-XII-1917.....	17-XII-1917.....	18	17
				Average.....	22	27

LIFE HISTORY

Methods of Study

In the study of the life history of this insect, lamp chimneys 17 centimeters in height and 8 centimeters in diameter were used as cages. The upper part of each cage was covered with cheese cloth so that there was a free circulation of air inside, thus keeping the flies under as nearly normal conditions as possible. Cowpea seeds were grown in earthen nursery pots varying in height from 9.5 to 15.5 centimeters and from 10 to 17 centimeters in diameter. As soon as the first two leaves of the plants were well started, the latter were inclosed by the cages with the flies turned loose inside. Honey was used to feed the flies and the feeding was done by putting the honey on the leaves in small drops by means of sharp pointed sticks.

There is one difficulty encountered in connection with the above type of cages used and that is moisture sometimes collects on the inside. This usually happens, however, after the adults have already deposited their eggs. The presence of the moisture is detrimental to the flies, as some of them will stick to the glass, and, unless relief is given, they die. This trouble was found to be remedied by making an opening on the side of the lamp chimney. The

opening made should be covered with a piece of cheese cloth of such a size as to allow a portion of the edges to be pasted on the glass. The use of a bigger lamp chimney was found to diminish the trouble. A type 17 centimeters in height and 12 centimeters in diameter was found to be satisfactory.

Another type of cage used consisted of cheese cloth with a wooden frame. While these cages allowed a greater circulation of air, yet they were found to be unsatisfactory, as the flies would always remain on the gauze, attempt to escape and refuse to oviposit. For this reason these cages were abandoned.

Since the eggs are deposited within the leaves, hatching was recorded as soon as mines began to be formed. This is accurate enough, as it was observed that the larvae commence feeding within twenty minutes after hatching. In one to two days after hatching, the larvae mine down the stem and with the aid of a hand lens they can be seen feeding just under the skin, frequently following one another in the same mine. In one to two days more, the larvae reach the base of the plants and do most of their feeding there. The plants in the pots usually begin to die in two to four days after the larvae commenced their operation in the base

of the stalks. When food in the base is nearly all consumed, the larvae ascend the stem of the plants in a position where their pupation can be easily recorded. In cases where larvae did not leave the base of the plants pupation was recorded by cutting that part of the plant open. Cutting the base of the plant twice a day, once in the morning and once in the afternoon, was found sufficient.

After pupation, the puparia were dissected out of the stalks of the plants and put in vials closed with a cotton plug and with a small quantity of slightly moist soil at the bottom.

The following records show the life history of *Agromyza destructor* as studied in the insectary. Nine generations were reared from 23 July, 1917, to 22 February, 1918, a period of 215 days.

FIRST GENERATION

Pot No. 1

- 23- VII-1917—8 females in captivity.
- 23- VII-1917—Eggs laid.
- 25- VII-1917—Eggs hatched.
- 27- VII-1917—Larvae in upper part of stem, descending.
- 28- VII-1917—Larvae at base of plants.
- 1-VIII-1917—Pupation.
- 9-VIII-1917—Puparia turned dark.
- 10-VIII-1917—Adults emerged.
- 13-VIII-1917—Copulation.

21

FIRST GENERATION

Pot No. II

- 24- VII-1917—Adults from Pot I transferred.
- 24- VII-1917—Eggs laid
- 26- VII-1917—Eggs hatched
- 28- VII-1917—Larvae in upper part of stem, descending.
- 29- VII-1917—Larvae at base of stem.
- 2-VIII-1917—Pupation.
- 10-VIII-1917—Puparia turned dark.
- 11-VIII-1917—Adults emerged.
- 13-VIII-1917—Copulation.

20

SECOND GENERATION

- 13-VIII-1917—3 pairs in copula reared from Pot I, 1st generation, put in cage.

- 14-VIII-1917—Eggs laid.
- 17-VIII-1917—Eggs hatched (at night).
- 19-VIII-1917—Larvae in upper part of stem, descending.
- 20-VIII-1917—Larvae at base of plants.
- 22-VIII-1917—Pupation.
- 30-VIII-1917—Puparia turned dark.
- 31-VIII-1917—Adults emerged.
- 3- IX-1917—Copulation.

21

THIRD GENERATION

Pot No. I

- 3-IX-1917—1 female put in cage.
- 3-IX-1917—Eggs laid.
- 6-IX-1917—Eggs hatched.
- 8-IX-1917—Larvae in upper part of stem, descending.
- 9-IX-1917—Larvae at base of plants.
- 13-IX-1917—Pupation.
- 21-IX-1917—Puparia turned dark.
- 22-IX-1917—Adults emerged.
- 24-IX-1917—1 pair in copula.

21

THIRD GENERATION

Pot No. II

- 4-IX-1917—1 female from Pot I, 3rd generation transferred.
- 5-IX-1917—Eggs laid.
- 7-IX-1917—Eggs hatched.
- 8-IX-1917—Larvae in upper part of stem, descending.
- 10-IX-1917—Larvae at base of plants.
- 14-IX-1917—Pupation.
- 22-IX-1917—Puparia turned dark.
- 23-IX-1917—Adults emerged.
- 25-IX-1917—2 pairs in copula.

20

FOURTH GENERATION

- 26-IX-1917—Adults reared from Pot II, 3rd generation, put in cage.
- 27-IX-1917—Eggs laid.
- 29-IX-1917—Eggs hatched.
- 1- X-1917—Larvae in upper part of stem, descending.
- 2- X-1917—Larvae at base of plants.
- 7- X-1917—Larvae pupated.
- 14- X-1917—Puparia turned dark.
- 15- X-1917—Adults emerged.
- 17- X-1917—Emergence completed.
- 16- X-1917—Copulation.
- 17- X-1917—Copulation.

20

FIFTH GENERATION

Pot No. I

- 18- X-1917—Adults put in cage.
 18- X-1917—Eggs laid.
 20- X-1917—Eggs hatched.
 22- X-1917—Larvae in upper part of stem,
 descending.
 29- X-1917—Pupation.
 7-XI-1917—Adults emerged.
 8-XI-1917—Emergence completed.

20

FIFTH GENERATION

Pot No. II

- 19- X-1917—Adults from Pot I, 5th generation,
 transferred.
 19- X-1917—Eggs laid.
 22- X-1917—Eggs hatched.
 29- X-1917—Larvae pupated.
 7-XI-1917—Adults emerged.
 8-XI-1917—Emergence completed.
 9-XI-1917—1 pair in copula.
 10-XI-1917—1 pair in copula.

21

SIXTH GENERATION

Pot No. I

- 10-XI-1917—Adults from Pot II, 5th gener-
 ation, put in cage.
 10-XI-1917—Eggs laid.
 12-XI-1917—Eggs hatched.
 14-XI-1917—Larvae in upper part of stem,
 descending.
 15-XI-1917—Larvae at base of plants.
 21-XI-1917—Pupation.
 29-XI-1917—Puparia turned dark.
 29-XI-1917—1 adult emerged.
 30-XI-1917—Emergence completed.

19½

SIXTH GENERATION

Pot No. II

- 11-XI-1917—Adults from Pot I, 6th generation,
 transferred.
 11-XI-1917—Eggs laid.
 13-XI-1917—Eggs hatched.
 15-XI-1917—Larvae in upper part of stem,
 descending.
 16-XI-1917—Larvae at base of stalks.
 22-XI-1917—Pupation.
 2-XII-1917—Flies emerged.
 4-XII-1917—Copulation.

23

SIXTH GENERATION

Pot No. III

- 12- XI-1917—Adults from Pot II transferred.
 12- XI-1917—Eggs laid.
 14- XI-1917—Eggs hatched.

- 16- XII-1917—Larvae in upper part of stem,
 descending.

- 17- XI-1917—Larvae at base
 22- XI-1917—Pupation.
 2-XII-1917—Adults emerged.
 4-XII-1917—Copulation.

22

SIXTH GENERATION

Pot No. IV

- 13- XI-1917—Adults from Pot III transferred.
 13- XI-1917—Eggs laid.
 15- XI-1917—Hatching.
 24- XI-1917—Pupation.
 3-XII-1917—Adults emerged.
 5-XII-1917—1 pair in copula.

22

SEVENTH GENERATION

Pot No. I

- 4-XII-1917—Adults from Pot I and Pot II
 of 6th generation, put in cage.
 4-XII-1917—Eggs laid.
 6-XII-1917—Eggs hatched.
 15-XII-1917—Pupation.
 26-XII-1917—Emergence.

22

SEVENTH GENERATION

Pot No. II

- 5-XII-1917—Adults from Pot I, 7th generation,
 transferred.
 5-XII-1917—Eggs laid.
 7-XII-1917—Eggs hatched.
 16-XII-1917—Pupation.
 27-XII-1917—Adults emerged.
 29-XII-1917—Copulation.

24

EIGHTH GENERATION

- 31-XII-1917—Adults reared from Pot II, 7th
 generation, put in cage.

- 1-I-1918—Eggs laid.
 3-I-1918—Eggs hatched.
 14-I-1918—Larvae pupated.
 23-I-1918—Puparia turned dark.
 24-I-1918—Adults emerged.
 28-I-1918—2 pairs in copula.

28

NINTH GENERATION

- 28- I-1918—Adults put in cage.
 28- I-1918—Eggs laid.
 31- I-1918—Eggs hatched.
 10-II-1918—Pupation.
 19-II-1918—Adults emerged.
 20-II-1918—Adults emerged.
 22-II-1918—Copulation.

25

FIRST GENERATION

Pot No. I

- 24- VII-1917—8 Adults in captivity.
 24- VII-1917—Eggs laid.
 26- VII-1917—Eggs hatched.
 26- VII-1917—Larvae in upper part of stalks,
 descending.
 29- VII-1917—Larvae at base of stalks.
 2-VIII-1917—Larvae pupated.
 10-VIII-1917—Puparia turned dark.
 11-VIII-1917—Adults emerged.
 13-VIII-1917—Copulation.

20

SECOND GENERATION

Pot No. I

- 13-VIII-1917—3 pairs in copula reared from
 1st generation put in cage.
 14-VIII-1917—Eggs laid.
 16-VIII-1917—Eggs hatched.
 18-VIII-1917—Larvae in upper part of stem,
 descending.
 19-VIII-1917—Larvae at base of stalks.
 23-VIII-1917—Pupation
 31-VIII-1917—Adults emerged.
 1- IX-1917—Copulation.

19

SECOND GENERATION

Pot No. II

- 14-VIII-1917—Adults from Pot I, 2nd gen-
 eration, transferred.
 15-VIII-1917—Eggs laid.
 17-VIII-1917—Eggs hatched.
 17-VIII-1917—Larvae in upper part of stem,
 descending.
 20-VIII-1917—Larvae at base of plants.
 24-VIII-1917—Pupation.
 2- IX-1917—Adults emerged.
 4- IX-1917—Copulation.

21

SECOND GENERATION

Pot No. III

- 15-VIII-1917—Adults from Pot II, 2nd gen-
 eration, transferred.
 16-VIII-1917—Eggs laid.
 18-VIII-1917—Eggs hatched.
 20-VIII-1917—Larvae in upper part of stem,
 descending.
 21-VIII-1917—Larvae at base of stem.
 25-VIII-1917—Pupation.
 4- IX-1917—Emergence.

20

THIRD GENERATION

Pot No. I

- 4-IX-1917—Adults reared from Pot III, 2nd
 generation, put in cage.
 4-IX-1917—Eggs laid.
 7-IX-1917—Eggs hatched.
 9-IX-1917—Larvae in upper part of stalks,
 descending.
 10-IX-1917—Larvae at base of plants.
 14-IX-1917—Pupation.
 22-IX-1917—Puparia turned dark.
 23-IX-1917—Emergence.

19

THIRD GENERATION

Pot No. II

- 5-IX-1917—Adults from Pot I, 3rd generation,
 transferred.
 5-IX-1917—Eggs laid.
 8-IX-1917—Eggs hatched.
 10-IX-1917—Larvae in upper part of stem,
 descending.
 11-IX-1917—Larvae at base.
 15-IX-1917—Pupation.
 23-IX-1917—Pupae turned dark.
 24-IX-1917—Emergence.

19

FIRST GENERATION

Pot No. II

- 25- VII-1917—Adults from Pot I, 1st genera-
 tion, transferred.
 25- VII-1917—Eggs laid.
 27- VII-1917—Eggs hatched.
 28- VII-1917—Larvae in upper part of stem,
 descending.
 29- VII-1917—Larvae at base of stem.
 2-VIII-1917—Pupation.
 11-VIII-1917—Puparia turned dark.
 12-VIII-1917—Adult emerged.
 13-VIII-1917—Copulation.

20

SECOND GENERATION

Pot No. I

- 13-VIII-1917—Adults reared from Pot II, 1st
 generation put in cage.
 14-VIII-1917—Eggs laid.
 16-VIII-1917—Eggs hatched.
 19-VIII-1917—Larvae at base of stalks.
 22-VIII-1917—Pupation.
 1- IX-1917—Adults emerged.

19

SECOND GENERATION

Pot No. II

- 14-VIII-1917—Adults from Pot I, 2nd generation, transferred.
 15-VIII-1917—Eggs laid.
 17-VIII-1917—Eggs hatched.
 19-VIII-1917—Larvae in upper part of stem, descending.
 20-VIII-1917—Larvae at base of stalks.
 24-VIII-1917—Larvae pupated.
 2- IX-1917—Adults emerged.
 4- IX-1917—Copulation.

21

SECOND. GENERATION

Pot No. III

- 15-VIII-1917—Adults from Pot II, 2nd generation, transferred.
 16-VIII-1917—Eggs laid.
 18-VIII-1917—Eggs hatched.
 20-VIII-1917—Larvae in upper part of stem, descending.
 21-VIII-1917—Larvae at base of plant.
 25-VIII-1917—Pupation.
 4- IX-1917—Adults emerged.

20

THIRD GENERATION

Pot No. I

- 6-IX-1917—Adults reared from Pot I, 2nd generation, put in cage.
 7-IX-1917—Eggs laid.
 9-IX-1917—Eggs hatched.
 12-IX-1917—Larvae at base of stalks.
 16-IX-1917—Pupation.
 27-IX-1917—Emergence.
 29-IX-1917—Copulation.

23

THIRD GENERATION

Pot No. II

- 4-IX-1917—Adults reared from Pot II, 2nd generation, put in cage.
 5-IX-1917—Eggs laid.
 7-IX-1917—Eggs hatched.
 9-IX-1917—Larvae in upper part of stem, descending.
 10-IX-1917—Pupation.
 22-IX-1917—Puparia turned dark.
 23-IX-1917—Adults emerged.

19

THIRD GENERATION

Pot No. III

- 6-IX-1917—Adults from Pot II, 3rd generation, transferred.
 6-IX-1917—Eggs laid.

9-IX-1917—Eggs hatched.

10-IX-1917—Larvae in upper part of stem, descending.

11-IX-1917—Larvae at base of stalks.

15-IX-1917—Pupation.

23-IX-1917—Puparia turned dark.

24-IX-1917—Adults emerged.

26-IX-1917—Copulation.

20

FOURTH GENERATION

Pot No. I

- 26-IX-1917—Adults reared from Pot II, 3rd generation in cage.
 27-IX-1917—Eggs laid.
 29-IX-1917—Eggs hatched.
 1- X-1917—Larvae in upper part of stem, descending.
 2- X-1917—Larvae at base of stalks.
 6- X-1917—Pupation.
 14- X-1917—Puparia turned dark.
 15- X-1917—Adults emerged.
 16- X-1917—Emergence completed.
 17- X-1917—Copulation.

21

FOURTH GENERATION

Pot No. II

- 26-IX-1917—Adults from Pot I, 3rd generation, put in cage.
 27-IX-1917—Eggs laid.
 29-IX-1917—Eggs hatched.
 1- X-1917—Larvae in upper part of stem, descending.
 2- X-1917—Larvae at base of stalks.
 7- X-1917—Pupation.
 14- X-1917—Puparia turned dark.
 15- X-1917—Adults emerged.
 16- X-1917—Emergence completed.
 17- X-1917—Copulation.

21

FOURTH GENERATION

Pot No. III

- 27-IX-1917—Adults from Pot I, 4th generation, transferred.
 28-IX-1917—Eggs laid.
 30-IX-1917—Eggs hatched.
 2- X-1917—Larvae in upper part of stem, descending.
 3- X-1917—Larvae at base of stalks.
 6- X-1917—Pupation.
 15- X-1917—Puparia turned dark.
 16- X-1917—Adults emerged.
 17- X-1917—Emergence completed.
 18- X-1917—Copulation.

21

FOURTH GENERATION

Pot No. IV

- 27-IX-1917—Adults from Pot II in 4th generation, transferred.
 28-IX-1917—Eggs laid.
 1- X-1917—Eggs hatched.
 2- X-1917—Larvae in upper part of stem, descending.
 3- X-1917—Larvae at base of stalks.
 7- X-1917—Pupation.
 15- X-1917—Puparia turned dark.
 16- X-1917—Adults emerged.
 17- X-1917—Emergence completed.

19½

FIFTH GENERATION

Pot No. I

- 17- X-1917—Adults reared from Pot II in 4th generation, in cage.
 18- X-1917—Eggs laid.
 20- X-1917—Eggs hatched.
 21- X-1917—Larvae in upper part of stem, descending.
 23- X-1917—Larvae at base of stalks.
 27- X-1917—Pupation.
 5- XI-1917—Adults emerged.
 7- XI-1917—Emergence completed.

20

FIFTH GENERATION

Pot No. II

- 18- X-1917—Adults used in Pot I in 5th generation, transferred.
 18- X-1917—Eggs laid.
 21- X-1917—Eggs hatched.
 23- X-1917—Larvae at base of stalks.
 28- X-1917—Pupation.
 6-XI-1917—Adults emerged.
 8-XI-1917—Emergence completed.
 8-XI-1917—Copulation.

21

FIFTH GENERATION

Pot No. III

- 17- X-1917—Adults from Pot I in 4th generation, put in cage.
 18- X-1917—Eggs laid.
 20- X-1917—Eggs hatched.
 22- X-1917—Larvae in upper part of stem, descending.
 23- X-1917—Larvae at base of stalks.
 28- X-1917—Pupation.
 5-XI-1917—Adults emerged.
 6-XI-1917—Emergence completed.

19½

FIFTH GENERATION

Pot No. IV

- 18- X-1917—Adults used in Pot III in 4th generation, transferred.
 19- X-1917—Eggs laid.
 21- X-1917—Eggs hatched.
 22- X-1917—Larvae in upper part of stem, descending.
 23- X-1917—Larvae at base.
 29- X-1917—Pupation.
 6-XI-1917—Adults emerged.
 8-XI-1917—Emergence completed.
 10-XI-1917—Copulation.

23

FIFTH GENERATION

Pot No. V

- 20- X-1917—Adults from Pot IV in 5th generation, transferred.
 20- X-1917—Eggs laid.
 22- X-1917—Eggs hatched.
 30- X-1917—Pupation.
 8-XI-1917—Adults emerged.
 9-XI-1917—Emergence completed.
 11-XI-1917—Copulation.

22

SIXTH GENERATION

Pot No. I

- 10-XI-1917—Adults reared from Pot IV in 5th generation, put in cage.
 10-XI-1917—Eggs laid.
 12-XI-1917—Hatched.
 21-XI-1917—Pupation.
 30-XI-1917—Emergence.

20

SIXTH GENERATION

Pot No. II

- 11-XI-1917—Adults from Pot in 6th generation, transferred.
 11-XI-1917—Eggs laid.
 13-XI-1917—Hatched.
 15-XI-1917—Larvae in upper part of stem, descending.
 16-XI-1917—Larvae at base of stalks.
 22-XI-1917—Pupation.
 30-XI-1917—Adults emerged.
 4-XII-1917—Copulation.

23

SIXTH GENERATION

Pot No. III

- 12- XI-1917—Adults from Pot II in 6th generating, transferred.
 12- XI-1917—Eggs laid.
 14- XI-1917—Eggs hatched.
 16- XI-1917—Larvae in upper part of stem, descending.
 16- XI-1917—Larvae at base of stalks.
 23- XI-1917—Pupation.
 1-XII-1917—Puparia turned dark.
 2-XII-1917—Emergence completed.
 4-XII-1917—Copulation.

22

SIXTH GENERATION

Pot No. IV

- 13- XI-1917—Adults from pot III in 6th generation, transferred.
 13- XI-1917—Eggs laid.
 15- XI-1917—Hatched.
 24- XI-1917—Pupation.
 2-XII-1917—Puparia turned dark.
 3-XII-1917—Emergence.

20

SEVENTH GENERATION

Pot No. I

- 4-XII-1917—Adults reared from Pot II in 6th generation, put in cage.
 4-XII-1917—Eggs laid.
 6-XII-1917—Hatched.
 14-XII-1917—Pupation.
 16-XII-1917—Pupation completed.
 26-XII-1917—Emergence.
 29-XII-1917—Copulation.

25

SEVENTH GENERATION

Pot No. II

- 5-XII-1917—Adults from Pot I in generation, transferred.
 5-XII-1917—Eggs laid.
 7-XII-1917—Hatched.
 16-XII-1917—Pupation.
 17-XII-1917—Pupation completed.
 27-XII-1917—Adults emerged.
 30-XII-1917—Copulation.

25

EIGHTH GENERATION

- 31-XII-1917—Adults from Pot II in 7th generation, put in cage.
 1-I-1918—Eggs laid.
 3-I-1918—Hatched.
 14-I-1918—Pupation.
 23-I-1918—Puparia turned dark.

24-I-1918—Emergence.

26-I-1918—Copulation.

26

NINTH GENERATION

- 27- I-1918—Adults reared from 8th generation, in cage.
 28- I-1918—Eggs laid.
 31- I-1918—Hatched.
 9-II-1918—Pupation.
 10-II-1918—Pupation completed.
 19-II-1918—Adults emerged.
 20-II-1918—Emergence completed.
 21-II-1918—Copulation.

25

The foregoing records show that the life cycle of *Agromyza destructor* varies from 19 to 28 days, or an average of 21 days. They further show that the life cycle does not vary much from season to season, although it is slightly, lengthened from December to February, due undoubtedly to the cool weather.

NATURAL ENEMIES

Two hymenopterous parasites belonging to the family Chalcididae, which undoubtedly render no little help in the control of *Agromyza destructor*, were reared by the writer from puparia collected at various times from the field. Professor Baker informed the writer that he also reared two hymenopterous insects from the puparia of this pest. Specimens were sent by him to A. A. Girault and they received the names *Eurytoma poloni* and *Paratrigonogastra stella*, respectively. Professor Baker identified the parasites reared by the writer as being identical with the ones he reared. Unfortunately, Girault's descriptions are not available at this writing. The following brief descriptions, prepared from specimens in the collection, will enable the observer to differentiate between the two species and then be in a position to determine which of the two is more prevalent at a given season or in a given lot of parasitized fly puparia.

DESCRIPTIONS OF PARASITES

Eurytoma poloni Girault

Female—Length 1.5 millimeters; shining black. Head about two thirds as long as broad, punctuate with white pubescence; frontal and vertical pubescence more minute; front about two-thirds of head width; eyes reddish black with sparse very minute pubescence; ocelli translucent yellow, but black in fresh specimens, arranged in a triangle, the base of which is about twice as long as either side; antennae moniliform, mostly black and with white pubescence; pedicel brownish yellow; cheek about two-thirds of eye height. Thorax about twice as long as head but slightly narrower, punctate, with white pubescence; coxae black with few white hairs; femora black, except at distal extremity which is brownish yellow; front tibia brownish yellow; middle and hind tibiae dark, excepting at both extremities which are brownish yellow; hind tibia strongly bristled along posterior border; front tarsi, brownish yellow; middle and hind tarsi lighter than front tarsi, excepting the distal segments which concolorous with front tarsi. Wings hyaline and covered with minute setae; veins brownish yellow; marginal vein about twice as long as stigmal. Abdomen slightly longer than thorax and is very highly polished; weakly punctuate, almost glabrous; tip of abdomen brownish yellow.

Paratrigonogastra stella Girault

Female—Length 1.5 to 1.8 millimeters. Metallic green. Head punctuate about twice as long as broad with whitish pubescence; compound eyes brownish black and with a few very minute hairs; ocelli translucent, brownish yellow, arranged in triangle, the base of which is about twice as long as either side; antennae with white pubescence; scape and pedicel concolorous with ocelli; cheek about one-fourth the eye height. Thorax punctuate, more than twice as long as head, but slightly narrower than the latter, sparsely pubescent; coxae punctate, concolorous with thorax and with few hairs; remaining segments of legs brownish yellow, excepting the last tarsi which are dark brown; ungues dark. Wings hyaline and covered with minute setae; veins brownish yellow; marginal veins slightly more than three times the length of the stigmal. Caudad of and nearly in line with the root of the posterior wing is a group of white hairs which is directed caudad and which is distinctly longer than remaining hairs of thorax. Abdomen slightly longer than thorax and highly polished, almost glabrous; not punctate, excepting the petiole and the last two segments which are weakly so.

EXTENT OF PARASITISM

The following table gives an idea of the extent of parasitism based on the number of parasites that issued from puparia collected from the field at different times:

No. of puparia.	Date collected	No. of parasites issued <i>Paratrigonogastra stella</i>	issued <i>Eurytoma poloni</i> .	Total No. of parasites	Percentage of parasitism
231	1-VI-1916.....	10	11	21	9%
43	16-VII-1916.....	0	10	10	23%
15	16-IX-1916.....	0	7	7	46%
86	21-IX-1916.....	5	3	8	9%
22	20-IX-1916.....	1	1	2	9%
51	3-X-1916.....	3	3	6	11%
63	5-X-1916.....	4	0	4	6%
51	7-X-1916.....	6	12	18	35%
225	14-X-1916.....	12	8	20	8%
9	16-X-1917.....	0	3	3	33%
11	3-XI-1917.....	1	1	2	18%
26	6-XI-1917.....	2	1	3	12%
31	12-XI-1917.....	3	0	3	10%
Total 864	.....	47	60	107	224%
Average per cent of parasitism.....					17.

From the above table it appears that the percentage of parasitism averages 17. It may also be deduced that *Eurytoma poloni* is more abundant than *Paratrigonogastra stella*, 60 of the former as against 47 of the latter having been reared from 864 puparia.

Three individuals of the former species (*Eurytoma poloni*) have been reared from puparia which were reared also in the insectary. This shows that even in the laboratory the parasites are attracted by the flies.

CONTROL AND REMEDIAL MEASURES

The control of *Agromyza destructor* by spraying with a view to killing the maggot and saving the plants is a difficult, if not an impossible, task. This is due to the fact that the larvae work inside the leaf and stalk, and therefore can not be attacked by any spray of a concentration strong enough to kill them without doing injury to the plants. Moreover, even though damage to the plant could be avoided, the application of such a spray would require too much time and labor, which alone, to say nothing of the cost of the material makes it a proposition of which the economy is very doubtful.

Since the eggs are deposited in the leaves of the plants, the chief factor, which must be considered in the control of this pest, if chemicals or substances which could be obtained locally are to be resorted to, is the prevention of oviposition. If this could be done when the plants are young, beginning at the appearance of the first two leaves, they are practically safe. One way to prevent oviposition is by the application of a substance which is disagreeable to the flies but which is not injurious to the plants. In Australia method has been suggested to be employed in the control of the French Bean Fly, *Agromyza phaseoli* Coquillett, mentioned

previously in this paper, tar water being the substance mentioned. But for this method to be effective two conditions must obtain, namely, (1) the substance must be such as will remain on the leaf until such time as the plants have passed through the danger period and (2) it must be applied uniformly to both surfaces of the leaves. It is doubtful whether this method of control would be an economical one to use.

Another method of control which might reduce oviposition to its minimum is by killing the flies. This may be accomplished by the use of poisoned baits applied on the leaves of the young plants. Both sexes are very fond of honey or syrup and thin sugary solution. Sweetened Paris green and arsenate of lead would probably kill large numbers of them. The parasites of this fly feed readily on syrup but they do not usually appear until the larvae of the fly are present in large numbers in the stalks of the plants.

Obviously, the easiest and most economical way of controlling this pest is by cultural methods. It has been pointed out that of all varieties or species of beans studied and which are reported in this paper the greatest damage occurs on cowpeas and kidney beans and in this locality the insect does the most damage from January to April inclusive, 100 per cent destruction having been recorded for both of these beans during this period. This being the case, these most susceptible varieties should not be planted during these months but rather those which are resistant or immune to the attack.

As has been intimated previously, the best time to plant cowpeas and kidney beans in the region around Los Baños is during October and November. These beans, if planted during the rainy season, will produce heavy vegetation but few pods. Hence, to

grow them for seeds during these months does not pay. They will only serve as harborage and breeding places for this pest until the period suggested for their planting for seed comes.

It is a common practice at this college to grow cowpeas for green manure during the rainy season. If among the immune or resistant varieties reported in this paper, there be any that are just as good or better for this purpose, cowpeas should not be used.

In case the infestation by the maggots be so heavy that the young plants have little or no chance to survive, it will certainly pay to sacrifice the whole field. It is suggested that the plants be plowed under deeply and the ground firmed, but this operation must be carried into effect as soon as infestation is noted and long before pupation, otherwise it will be useless.

In small patches pulling out the plants that wilt and die or otherwise show signs of being badly infested will help very materially to lessen the numbers of this insect. Before pulling out the plants the soil around the bases should be loosened with a sharp pointed stick, otherwise the portions of the plants which contain most of the puparia will become detached and remain in the ground. Badly infested petioles should also be pulled off and destroyed. Catching the adults with nets, especially when plants are young, will lessen the injury to some extent, as each female is capable of laying, on the average, about 200 eggs.

Thorough and frequent cultivation and ample moisture supply when the plants are young enable them to grow rapidly and thereby resist the attacks of the maggots. In cases where dry weather follows the germination of the seeds, occasional irrigation followed by frequent cultivation should be practiced.

One method of control which has been followed at this college in connection with the cultivation of kidney and Lima beans, is to hill the soil around the bases of the plants. This induces the growth of roots above the damaged portion of the stalk.

The flies breed freely in volunteer beans. Those beans should, therefore, be destroyed.

SUMMARY

1. The adult *Agromyza destructor* lays its eggs in punctures in the leaves of beans and the resulting maggots are leaf miners at first. This is contrary to the common belief that the maggots enter the stem near or under the surface of the ground.

2. The larvae attack only the stalk and the petioles of the leaves. Hence the name "legume-root maggot," as the larva was formerly called, is not a proper designation.

3. The larvae leave the leaves in one to two days after hatching and mine the stalk in which they work in greater numbers at the base, causing the tissues to decay.

4. This insect is the worst pest to young beans in this locality, and undoubtedly throughout the Philippines, sometimes destroying whole fields.

5. In this locality the pest is most destructive to kidney beans and cowpeas, especially from January to April, inclusive.

6. The Limas and the patani, both belonging to the same species, *Phaseolus lunatus*, are the most resistant to the attack of this pest. Moreover, they are only attacked at the time of appearance of the first two leaves.

7. As far as observed, seven species of beans are immune from the attack.

8. The adult is a very small fly, the male measuring about 1.2 millimeters and the female 1.7 millimeters.

9. The life cycle of the insect averages 21 days. It is slightly longer during the period from December to February, undoubtedly due to the cooler weather.

10. The female lives slightly longer than the male, the average obtained for the former being 38 days and the latter 37 days.

11. The female is capable of laying an average of 200 eggs.

12. This pest has two known hymenopterous parasites—*Eurytoma poloni* Girault and *Paratrigonogastra stella* Girault—both belonging to the family Chalcididae. Figures show that *Eurytoma poloni* is more abundant than *Paratrigonogastra stella*.

13. The control of this pest by spraying is a difficult matter and probably would not be a paying proposition. This pest can be more easily and cheaply controlled by cultural methods. Crop rotation and planting immune or resistant beans during the season of greatest destructiveness will undoubtedly operate to check the ravages of this pest.

ACKNOWLEDGMENTS

I am under obligation to Professor Charles S. Banks, Chief of the Department of Entomology, for his valuable advice and criticisms throughout the progress of this work. I am also indebted to Professor Charles F. Baker, Acting Dean of the College of Agriculture, under whom this study was first undertaken. My thanks are also due to Professor Baker for some references, for the description of the fly, and for the identification of the parasites. I am also under obligation to Mr. Leopoldo B. Uichanco, Instructor in Entomology, for the photographs, for some valuable suggestions relating to certain phases of the work, and for references.

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1. Egg in leaf puncture. $\times 60$

2. Egg. $\times 60$

3. Larva, first instar. $\times 63$

4. Mouth armature of larva in the first instar. $\times 250$

5. *Ditto*, second instar. $\times 200$

6. Larva, second instar. $\times 37$

7. Larva, third instar. $\times 42$

8. Larva, full grown. $\times 25$

9. Puparium, dorsal aspect. $\times 25$

10. *Ditto*, ventral aspect. $\times 25$

PLATE II



1. Head with ptilinum. $\times 22$
2. Head, dorsal aspect. $\times 50$
3. Female ovipositor. $\times 55$
4. Male abdomen, dorsal aspect. $\times 50$
5. Head of female. $\times 50$
6. Male abdomen, lateral aspect. $\times 50$
7. Caudal segments of female, ventral aspect. $\times 50$
8. Caudal segments of female, lateral aspect, showing ovipositor partially protruded. $\times 50$
9. Caudal segments of male, ventral aspect. $\times 50$

10. Wing, male. $\times 26$
11. Mesonotum and scutellum, male. $\times 50$
12. Male abdomen, lateral aspect. $\times 42$
13. Wing, before expanding. $\times 61$
14. Female abdomen, lateral aspect. $\times 32$
15. Caudal segments of female, dorsal aspect. $\times 50$
16. Adult male, lateral aspect. $\times 37$
17. Adult female, lateral aspect. $\times 35$
18. Male genitalia, lateral aspect. $\times 55$

PLATE III



1. Swellings in stem as a result of the attack of *Agromyza*, and tunnel leading to underground portion of plant. $\times 1$.
2. Infested stem, with cortex split open to show pupae in place. $\times 1$
3. Infested plant showing punctures on leaf and tunnels leading to underground portion of plant. $\times 1$



Photo by L. B. Uichanco.

Swellings and ruptures on stem and root resulting from the attack of *Agromyza*. $\times 1.2$

PLATE V

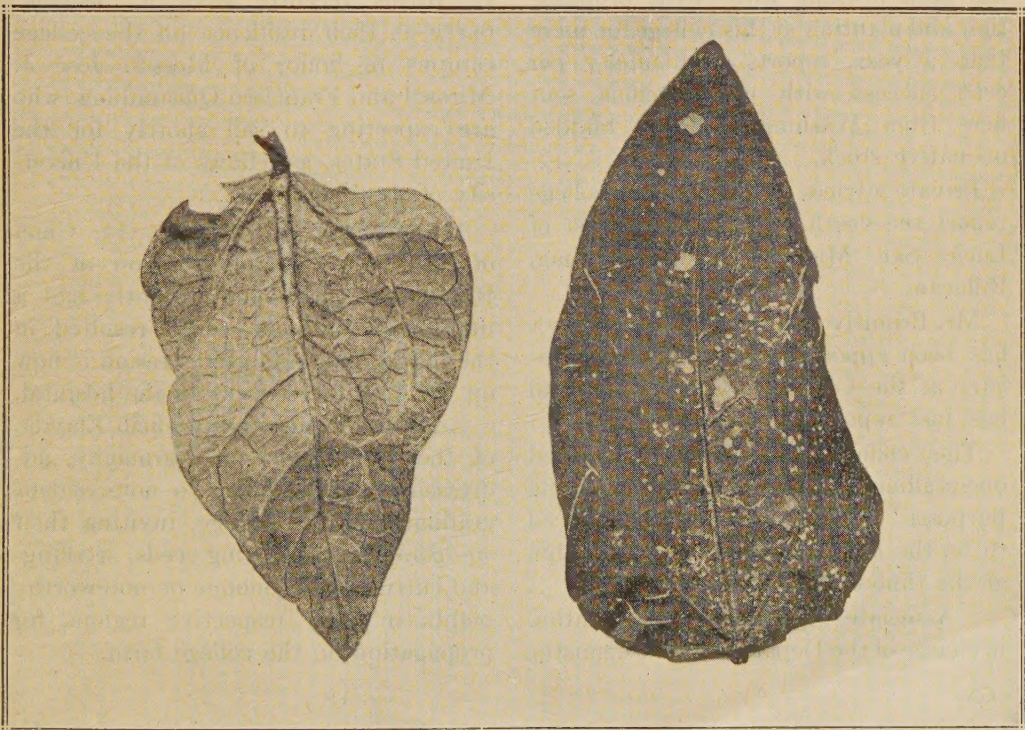


Photo by L. B. Uichanco.

Leaves showing punctures and tunnels. Left: nether aspect; right: upper aspect. $\times 1.2$

COLLEGE AND ALUMNI NOTES

As a result of the activity of a committee with Mrs. C. R. Gillis as chairman and Mrs. Manuel L. Roxas, Mrs. B. M. Gonzalez, and the Misses Manuela Kalaw, Ursula Villegas, Dionisia Lapie and Aurelia Manzanilla as members, the Red Cross drive on July twelfth netted about ₱600 from contributions by members of the faculty and students of the College of Agriculture and the School of Forestry.

Dr. W. T. Swingle, of the Bureau of Plant Industry, U. S. D. A., accompanied by Mrs. Swingle, was at Los Baños for a number of days on a business trip, investigating the progress of the experiments on citrus which are being conducted at this college by co-operation with the Washington office.

Mr. Mariano Medalla, '17, assistant in citriculture of the U. S. D. A., who has been working with citrus propagation and planting at this college for more than a year, reports over ninety per cent success with citrus scions sent here from Washington when budded on native stock.

Private advices received at this college report the death on July fourth last of Lucio San Miguel, '16, at Baliuag, Bulacan.

Mr. Primitivo Ramos, '18 (Pharmacy), has been appointed assistant in chemistry at the College of Agriculture, and has just reported for duty.

The college has recently acquired one stallion and two mares for breeding purposes. The stallion was pronounced to be the best conformed horse in Lipa at the time of his purchase.

Associate Professor F. W. Ashton, in charge of the Department of Chemistry

arrived on a recent transport with wife and children after a short leave of absence with permission to visit the United States, and has already reported for duty.

Thousands of slips of superior strains of native pineapples are being distributed to farmers in the vicinity of the college. The widespread propagation of such strains in private farms, together with the gradual adoption of improved cultural methods in use at this college, is expected to show results ultimately in a better quality of pineapples for local markets.

Mr. Alfredo P. Adriano, '14, is now in Japan, where he has established himself as an exporter of general merchandise. His present address is Koishikawa, P. O. Box No. 1, Tokyo.

Assistant Professor and Mrs. Manuel L. Roxas recently gave a "lechon" party at their residence on the college campus in honor of Messrs. José J. Mirasol and Francisco Quisumbing, who are expecting to sail shortly for the United States, as fellows of the University of the Philippines.

Mr. Gonzalo F. Merino, '14, Chief of the Pest Control Division of the Bureau of Agriculture, recently had a motorcycle accident which resulted in the loss of one leg. Mr. Merino is now on the way to recovery in the hospital.

Assistant Professor Inocencio Elayda, of the Department of Agronomy, addressed a circular letter to non-resident graduates of the college, inviting their co-operation in securing seeds, seedlings and cuttings of economic or noteworthy plants in their respective regions for propagation on the college farm.



THE DELEGATION OF THE FOURTH AGRICULTURAL CONGRESS TO THE COLLEGE OF AGRICULTURE